# Part C

## WATER JOINT PROGRAMMING INITIATIVE

*WATER CHALLENGES FOR A CHANGING WORLD*

# 2018 JOINT CALL

# Closing the Water Cycle Gap

## "WATER MANAGEMENT FOR SUSTAINABLE USE AND PROTECTION OF PEATLANDS"

## "WATERPEAT"

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# 1. EXCELLENCE

## 1.1 Introduction

**Peatlands** are common **in humid climates** and regions with significant rainfall excess. **Peatlands cover large areas of northern Europe** (e.g. Finland 33 %, Ireland 21 %, and Norway 6 % of land cover) and the **tropics** (e.g. Indonesia 8 %). Peatlands are **important** for water quality and regulation of river flow. They provide many ecosystem services (food, timber, carbon sequestration[1], water retention, recreation etc.) **In Europe, peatlands have been drained for agriculture, forestry and peat extraction. Peatlands are particularly important in some regions of Europe** such as Finland and Ireland, **which have a large peatland cover,** and in some regions such as in coastal Norway, where **other types of land are scarce** for agriculture. In Finland, peatland forestry provides 25 % of the annual forest growth. In Finland and Ireland, peat is also extracted and used for fuel at a large scale.

**Peatland use has a long history** in Europe reaching back to the Viking period. In the past, peatland drainage was **linked to governmental strategies in Northern Europe** to increase land and food security and prevent emigration (to the USA). **Currently**, peatland use for agriculture, forestry and peat extraction (harvesting) is directly or indirectly linked to several EU policies (e.g. Water Framework Directive (WFD), the Habitat and the Nitrates Directives, Paris Climate Treaty, 4 Per Mille Initiative). Peatland use is especially important for the **rural economy and communities.**

## 1.2 State-of-the-art and relation to the work programme

The proposal is linked to WaterJPI2018 call themes 1 and 2, and in particular sub-themes 1.1, 1.2, 1.3 (Table 1). We first provide a state-of-the-art and raise some key issues about peatland water management that need more attention.

***State-of-the-art and beyond***

Peatland **drainage leads to several negative impacts on water resources due to peat erosion, leaching of nutrients, organic matter and iron (Fe).** Drained peatlands require special attention if they are in contact with **acid sulphate soils[2],** where sulphate oxidation leads to **acid surges and poor ecological status of surface waters.** Leaching of **humic acids, Fe** and **dissolved organic matter (DOC)** are common characteristics of peatlands that effect water usability e.g. drinking water or recreation. As phosphorus (P) affinity (sorption) to peat soils is low**, P runoff after fertilizer application is a risk for surface water.** Greenhouse gas (GHG) emissions, subsidence and **peatland fires** are particularly severe in the tropics such as Indonesia. The impacts of peatland drainage are also severe for the **socio-economic system** (utilities, farmers, industry) **and the environment** (eutrophication, loss of habitats and spawning grounds etc). **Peatland management requires careful land and water management[3] to reduce a range of negative impacts on water resources and their ecosystem services** (drinking water, recreation, carbon sequestration, water retention etc.)

**Peatland use and water management is regulated by different policies and practices**. In Finland, Ireland and Norway, peat harvesting requires an **environmental permit** (as part of the Environmental Impact Assessment Directive) which includes a series of water treatment options. In Indonesia, plantation forestry **requires a concession** (permit). In Finland, pristine sites are rarely drained, whereas in Norway drainage is done if a permit is granted for agriculture, but not for forestry. Ditch cleaning on peatlands is allowed in Finland, also on sites that are almost pristine and connected to Natura 2000 sites (Habitat Directive). The **WFD** has set measures also for peatlands in the River Basin Management Plans, but the **effectiveness of the planned and proposed mitigation measures is uncertain.**

R**equirements for peatland management are typically set for** (i) water quality (removal efficiency and/or concentration) (ii) minimum peat water table depth (e.g. 40 cm to prevent subsidence) (iii) peat depth (iv) long-term after-use options that range from rewetting for restoration, to agriculture and forestry. **The basis for setting these criteria are not always scientifically sound or practically feasible**. Some criteria have been set based on what is known on or GHG emission processes, but the impact on water quantity and quality is not well known. Rewetting is seen as a promising way to limit impacts, but not all peatlands can be rewetted due to topographic, hydrological, or other limitations (e.g. land-ownership).

[1] Leifeld & Menichetti. 2018. The underappreciated potential of peatlands in global climate change mitigation strategies. *Nature Com.*
[2] Ruprecht *et al.* 2018. Estuarine dynamics and acid sulfate soil discharge: Quantifying a conceptual model. *Ecological Engineering*.
[3] Nieminen *et al*. 2018. Ditch network maintenance in peat-dominated boreal forests: *Ambio* https://doi.org/10.1007/s13280-018-1047-6

Lack of **knowledge on land and water management** is a key issue in peatland management, which hampers sound decision-making. Unknown issues **are**:

- **how does peatland drainage and use effect hydrology and water quality at field and catchment scale?** How can leaching and other negative impacts be limited by water table management, water retention, land conservation and different water treatment options to reduce downstream effects (drinking water quality, recreation, biodiversity etc.)
- **which peatland areas should be protected from drainage and intensive land use, and which can be used with limited environmental impacts?** How can peatlands be delineated and zoning applied to conserve valuable systems, limit environmental impacts on environment, and reduce peatland fire risk (and spread of fire to protected peatlands)?
- **what type of water pollution control structures** (e.g. constructed wetlands, peak runoff control) **and other measures** (e.g. restoration, soil amendments) are **best suited** considering their costs and effectiveness?
- **how can land and water management be combined in a sustainable way** to limit impact of water for human consumption and the other environmental impacts? How can new technologies be best applied to protect surface water resources?

**More precise information** is needed to guide water management decisions makers. At field and catchment scale, having **more accurate data could allow for spatial zoning,** where valuable peatlands are better protected or conserved.

***Relation to the work programme***

**Table 1** A short analysis of WATERPEAT relation to the work programme.

| |
|---|
| **Sub-theme 1.1 - Promoting adaptive water management for global change.** |
| The proposal looks into different water management solutions for different type of peatlands' environmental and socio-economic challenges. This work will allow decision makers to select solutions to mitigate global change impacts (pollution, GHG emission, biodiversity loss) of typical peatland uses such as forestry, agriculture and peat extraction. The work will also examine water management options that maintain or improve surface water quality, improve environmental protection (reduced leaching) and restoration of peatlands (improved water retention, biodiversity, carbon (C) sequestration). |
| **Sub-theme 1.2 - Integrative management by implementing Natural Water Retention Measures (NWRM) such as Managed Aquifer Recharge (MAR).** |
| The proposal explores methods to retain water for (i) water quality improvement (ii) restoration (iii) flood control (iv) drought mitigation and fire risk reduction through water table management and peatland restoration. |
| **Sub-theme 1.3 - Mitigating water stress in coastal zones and urbanized deltas.** |
| Peatlands are often found in the coast and on coastal islands (e.g. Norway and Indonesia). In these regions, water quality is often an issue (e.g. salinity, DOC, acid soils). The proposal examines land use and management options for biomass and local food production in Indonesian coastal lowlands, where saline water intrusion into peatlands is a key problem along with subsidence leading to soil acidity. In the coastal zone, land management is often intense and in conflict with drinking water protection; this will be examined. We will also look into options for paludiculture (wetting, restoration and agroforestry in wet conditions) and the pros and cons and the potential bottlenecks related to this measure. |
| **Sub-theme 2.1 - Integrating economic and social analyses into decision-making processes.** |
| We will examine the effectiveness of policies (e.g. monitoring compliance on water table) to reduce negative impacts from peatland management. Various sustainable peatland use and protection options will be considered. |
| **Sub-theme 2.2. – Re-use of water.** |
| The re-use aspects cover use of waste materials for runoff water treatment (Ireland, Finland) and use of runoff water in aquaculture (Indonesia) in peatlands on coastal lowlands. |
| **Sub-theme 2.3 - Connecting science to society.** |
| We will involve several stakeholders and build their capacity to understand peatland water management. |
| **Sub-theme 2.4 - Promoting new governance and knowledge management approaches.** |
| We will develop aspects relevant for permission, monitoring, mitigation and compliance that are needed in integrated peatland land and water management. |

### 1.3 Objectives and overview of the proposal

The **main objectives are to develop peatland water management for different land use options and environmental protection goals**. The project aims to:

I) Improve our knowledge on peatland hydrological and geochemical processes, so that decision and policy makers (e.g. ministries) can make scientifically-based decisions regarding impacts on the water environment,

II) Develop and test methods to reduce leaching (DOC, P, Fe and acidity) and other negative impacts that occur after peatland drainage, so that drinking water producers (utilities), other water users and biodiversity are better protected,

III) Develop, test and disseminate knowledge in water management approaches and technologies with stakeholders (e.g. SME sector) that can be applied for a more efficient land use and water management.

During the WATERPEAT project, **more specifically, we will**:

- **Measure and characterize different peatlands, their soil physical properties and the hydrogeological setting using data** from Norway (2-4 sites), Finland (2-3 sites) and Indonesia (1 island with 6 sites),
- **Study** p**eat soil geochemistry and reasons for nutrient (P, nitrogen (N)), acidity (pH, alkalinity), Fe and DOC leaching using** field, catchment, and rainfall simulation experiments in Ireland, Finland and Norway,
- **Model hydrology and water quality variation** using data from Finland, Norway and Indonesia using numerical models. Simulation past and future conditions, assess extremes (flood, drought) using future climate scenarios.
- **Jointly review and test new options for mitigation and restoration to limit leaching** (land use planning, treatment methods), **land and water resources degradation,** and **peatland biodiversity loss**,
- **Develop with stakeholders improved options for land use planning, surveillance and zoning practices** to reduce downstream environmental impacts, provide guidance for sustainable biomass production and maintenance of other ecosystem services.

### 1.4 Research methodology and approach

WATERPEAT will develop methods to prevent and mitigate different negative impacts related to peatland drainage. We will **combine data from well-monitored** sites at different type of peatlands in different climatic regions. This, along with the partners' experience, will provide a broad and integrated understanding on peatland water management. The approach is **holistic, building on the different partner expertise** (hydrology, water engineering, geochemistry, modelling, remote sensing etc.) and **including stakeholder knowledge** [ministries, regional environmental protection, water utilities, land users, planners, ICT (information and communication technology)-related water industry]. The **results will be combined, compared and demonstrated using novel visual conceptual models**. We will also advance the use of **numerical hydrological modelling by providing baseline data** needed for climate change assessment and to test **efficiency and feasibility of different water management and protection options**. The research combines data from **remote sensing**, ground-based observation, **ICT and IoT** (internet of things) solutions and numerical modelling. We will **collaborate with practitioners, regulators, policy makers and the innovation sector to develop methods** to delineate peatland catchments for a more targeted water protection and restoration. We will **also provide** methods that are feasible and adapted for conditions found in **low income countries** such as Indonesia.

**Overview on methods and innovation:**

- The **research methodology** includes e.g. (i) **analysis of data from on-going field experiments** (database, calculations, modelling) (ii) **new measurements** to complement existing data banks (iii) **rainfall simulation and column experiments** to study key processes (iv) use of **remote sensing** (v) **numerical modelling** of peatland hydrology and water quality (vi) **reviews and studies** on runoff water treatment methods. We also use a systematic approach to involve stakeholders to share their experience and to provide input on how new methods could best be implemented in practice (see letter of commitments).
- The **innovation activities** include an **internet-based and publicly available platform on methods and procedures needed to assess peatland hydrology** and **limit impacts** of drainage on water quality (D4.8). We will provide a **dataset on hydrology and water quality** which is largely missing (D1.1). **New methods will be provided to reduce leaching** (D2.2). **We will provide protocols and guidelines** (D3.2) **on how to observe and monitor peatlands**

**including novel methods for remote sensing, ICT and IoT solutions** (e.g. for controlled drainage, water retention, pollution control, environmental permits and compliance monitoring). This will provide improved practices for land use planning (e.g. zoning of areas), best practices to reduce leaching and for drainage water treatment. The **end-products** will **be developed in collaboration with stakeholders and industry** (see attached letters).

**The research will be strongly linked to existing peatland research sites** in NORWAY, FINLAND and INDONESIA providing a strong starting point (as setting up new sites is costly and time consuming). The sites are owned or operated by project partners or jointly with our national collaborators (e.g. research institutes) and stakeholders (e.g. forest sector, farmers, peat harvesters, restoration agencies). In Ireland, we will use a unique **infrastructure** with rainfall simulation trials to study processes and treatment options in detail. **The peatland study sites are**:

- **NOR**: **Two grass cultivation sites** at Svanhovd (continental, subarctic climate) and Særheim (coastal, wet and warm). Well instrumented by a recent NFR-funded project MYR on GHG emissions. **Four forested peatlands** in south-eastern Norway (Tønsberg, Løten and Nome with boreal/cold temperate climate). The sites are part of the long-term experimental forest production trials in Norway (currently *ca.* 600 operative trials throughout the country; *ca.* 200 operative or sleeping trials on mires where effects of fertilizer level/type and ditching density are the most frequent research question). New measurements (for describing long-term site C budget) were carried out in 2017 (soil samples, soil chemistry, tree diameter and height, levelling, peat depth) including some reference plots.
- **FIN**: Ruukki experimental site (Continental, boreal climate) with **six different grassland fields** (variable peat depth and water table) instrumented by a regional EAKR/ESR project. **Restoration sites** instrumented and monitored in past and on-going Life projects (HYDROLOGY Life) and by UO[4]. **Peat extraction sites** data operated and recorded by our stakeholder (EHP). **Peatland forestry sites** (Finnish network of sites to which we have access)[5][6].
- **IND**: **Pedang peatland island experimental site** (wet and hot climate, costal) with **six regions being monitored intensively** by UGM for hydrology considering different uses such as **forestry, agriculture and restoration** with Sago palm (a natural wetland species used for food, with low glycemic index). The site is included in a PhD at UO (MSc Ismail). The site has a fairly pristine protected doom area (serving as a reference. UGM also have access to data on Borneo and is well connected with key stakeholders (e.g. see the Letter of Commitment from The Government of Indonesia's Peatland Restoration Agency).

### 1.5 Originality and innovative aspects of the research

The suggested work is, to our knowledge, **the first international collaborative effort targeted towards improved peatland water management**. **New information** will be obtained on peatland hydrology, modelling and water protection from different types of peatlands ranging from coastal Atlantic bogs used for agriculture (Norway) and forestry (Ireland), inland massive bogs under restoration (Norway), fens in Finland and bogs in Indonesia. The research suggested is **timely and linked to needs to solve different urgent issues** related to peatland use and protection (water quality, fires, acidity, subsidence, conservation, restoration, floods mitigation). The project will provide more information on the role of **subsoil and hydrogeological conditions** on water management such as calcium-rich sites in Ireland, and acidic sites in Finland and Indonesia. The approach used combines **different expertise** on hydrology, soil science, water quality, water management, forestry, agronomy, remote sensing, modelling, and environmental engineering. The consortium links important **peatland countries,** which all face similar problems with land and water management. **New techniques** will be used regarding observations and modelling of peatland land use, hydrology and leaching. Different water management methods will be compared and tested. The results obtained will be tested in an **interdisciplinary setting with stakeholders**, proving ways for a **transition** towards land and water management with less environmental impacts.

[4] Memberu MW, Marttila H, Tahvanainen T, Kotiaho JS, Hokkanen R, Kløve B, Ronkanen A-K. 2017. Changes in pore water quality after peatland restoration: Assessment of a large–scale, replicated Before-After-Control-Impact study in Finland. *Water Resources Research* 53, 8327–8343.

[5] M Nieminen, S Sarkkola, S Hellsten, H Marttila… 2018. Increasing and Decreasing Nitrogen and Phosphorus Trends in Runoff from Drained Peatland Forests—Is There a Legacy Effect of Drainage or Not? *Water, Air, & Soil Pollution*: 229:286.

[6] H. Marttila…, B. Kløve, S. Hellsten. 2018. Elevated nutrient concentrations in headwaters affected by drained peatland, *Science of the Total Environment* 643:1304-1313

### 1.6 Clarity and quality of transfer of knowledge for the development of the consortium partners

The consortium will advance the Water RDI (research, development and innovation) by **linking partners** that work on peatlands from different scientific backgrounds (hydrology, water management, remote sensing, agronomy and forestry). This will lead to a **holistic and integrated approach** that is needed to solve the diverse land and water management issues on peat soils. The partners include universities (UO, NUIG, UGM) doing basic and applied research, as well as a state research institute (NIBIO) that works on water and land use policy and regulation. The partners are collaborating with key stakeholders (see CVs) and the project will include a strong stakeholder collaboration approach (e.g. Task 4.3).

The new knowledge transferred between partners include:

- UO will benefit from NIBIOs expertise on remote sensing and bioeconomy research at large, and NUIG expertise on water treatment modelling and P leaching control.
- NUIG will benefit from land use management expertise at NIBIO and peatland expertise in UO.
- NIBIO will benefit from UO's expertise on peatland hydrology, peatland restoration and water protection.
- UGM will benefit from experts on peatland hydrology and water management in Europe, and the other partners will learn more about tropical peatlands and participate in the tropical peatland management and protection discussion.

### 1.7 Quality of the consortium partners and collaborative arrangements.

The proposal links researchers and institutes with a significant experience in peatlands, water research and water management. In particular, for each partner:

- **UO**: The project co-ordinator Bjørn Kløve (UO) is globally a (the) leading expert on peatland water management with more than 50 journal papers on this topic in leading water journals. His research team consisting of 30 researchers possess broad knowledge on peatland hydrology, water quality, observations, modelling and management. The team is currently involved in peatland projects such as PEATWISE (ERA-NET GAS on GHG emission mitigation), MYR (RCN -GHG mitigation), HYDROLOGY-LIFE (peatland restoration), SHIFTMIRE (on climate change and peatland hydrology), and the recently completed PEATLAND-Life (restoration). Recently, the team has engaged on tropical peatland studies in Indonesia (2 PhDs started on the topic) in collaboration with UGM. Besides the water team from UO, the proposal includes UO experts on ICT, IoT and SMEs.
- **NUIG**: The NUIG team have experience in field and laboratory-based work that have examined mitigation processes in peatlands. They were project partners on the EPA-funded Hydrofor project, which examined soil-water processes in forested peatlands and various mitigation options. They have authored more than 100 journal papers on soil-water processes, and have state of the art rainfall simulation and water analyses facilities in their laboratories.
- **NIBIO** participate with experts on peatland remote sensing (Dr. Solberg), hydrology (Dr. Kværner) and geochemistry, peatlands and GHG emissions from agricultural (Dr. Silvennoinen) and forest ecosystems (Dr Dalsgaard). NIBIO is the leading institute in Norway on peatland water and drainage related research with experience going back 100 years on peatland inventory for agriculture and forestry uses. The team is involved in projects such as PEATWISE, MYR, TropDec on tropical peatlands (Academy of Finland), RePeat on peatland restoration (EU-Biodiversa). Silvennoinen and Solberg are involved in studies on tropical peatlands (Malaysia, Indonesia) and the proposal will strengthen these ties (e.g. to UGM).
- **UGM** participate with experts on forestry, agriculture, land management, hydrology and hydraulics, and ecology. Oka Karyanto has long term experience on sustainable land/forest management in Indonesia. His research team is responsible for the Pedangn Island hydrological monitoring to which UO and NIBIO participate. Dr Satyawan Pudyatmoko is responsible for the peatland restoration work at UGM and Dr Istiarto is an expert in hydrology and hydraulics, including a monitoring set-up at Pedang island.

The proposal will link past expertise from different scientific fields. The joint research includes joint tasks, data analysis and reviews. The effort will lead into new discoveries on peatland water management. UO, NIBIO and UGM have worked together before. NUIG is a valuable addition to this collaboration.

## 2. IMPACT

### 2.1 Impact of the proposal

**The WATERPEAT project will directly reply to the main theme of the Water JPI Call,** as it links "*observations, experiments and modelling to better understand hydrological processes and their connection, and to analyse and forecast the effectiveness of management methods*." **Peatland water management is an urgent topic** in Finland, Indonesia, Ireland and Norway. Exploring the topics in a joint effort with a **critical mass** will provide a significant impact on **peatland water research**, which is required in the Call (*improve use of human resources, reduce fragmentation*). The partner countries provide good coverage on key peatland types found globally (coastal, inland, temperate climate, cold climate, tropics) providing the required "*national, basin and global scale*" approach (and way to generalize the results for a wide uptake of results). The planned work will *strengthen the European leadership* in peatland water management. The proposal focusses on *fresh water and coastal lowlands*, which is a *priority* of the Call (theme 1.3). Moreover, the proposal meets the FPO goals, as it is *transdisciplinary, combines basic (hydrology, geochemistry) and applied research (water treatment and management), includes mobility of research and promotes international collaboration.*

The **proposal meets the expectations listed in the Call,** as it *addresses several themes*, including the *UN SDGs* (see below). The planned work goes *beyond the state-of-the-art* on hydrology and water management of peatlands, by having *case studies in Europe and elsewhere*. It involves *stakeholders* and studies problems that are important for stakeholders (impact of peatland use on water quality, methods to mitigate negative water quality impacts, ways to mitigate floods using natural systems, methods to restore and measure restoration success, methods to reduce fire, land degradation and destruction of pristine rain forests). The studies are carried out in *different climatic regions, hydrological and soil conditions.* The project will consider *gender dimension* in project involvement, recruitment and leadership.

The project replies to **SDG 6**, as it aims to *protect and restore water related ecosystems such as wetlands* (peatland is the most common type of wetland), forests (much of the Indonesian forests are on peatlands). In addition, the proposal *builds capacity in developing countries and will strengthen the local community participation in water management*. The project research is well linked to **SDG 13** goals, as peatland management also has the goal to **limit subsidence and GHG emissions**. If well implemented, water management has the potential to **prevent fires, which destroy forests and consequently reduce soil and canopy C stocks.** The task on monitoring of forest fire and biomass is a method to **map C loss** providing a tool as listed in SDG13. Several of the water **management methods** studied provide a way to mitigate climate change effects (e.g. floods, droughts).

The proposal *builds on on-going research activities*, as it connects well-monitored case studies established in different countries. The **partners are all strong in the proposed field of research**, providing an interdisciplinary consortium that will *go beyond the state-of-the-art* and provide synergies (different approaches, methods, scientific fields, and experience). Authorities (ministries, regional authorities), industry, NGOs, SMEs and consultancy will be involved **as stakeholders and collaborators**.

**In the case of Indonesia**, improved peatland water management has a high national priority to reduce fire risk and to combat deforestation and GHG emissions (e.g. Norwegian REDD+ fund mechanism that can provide $1 billion USD if the speed of deforestation is reduced). In 2010, a Letter of Intent (LoI[7]) was signed between Norway and Indonesia, where Norway pledged $1 billion over five years towards efforts to cut GHG emissions in Indonesia, and this arrangement has been extended in time after that. In addition, Finland is committed to peatland management with Indonesia on its highest political agenda (President's visit to Indonesia, ministry memorandum of collaboration[8]). See also the Letter of Commitment on the Indonesian collaboration by Finnish Ministry of Agriculture and Forestry.

### 2.2 Expected outputs

The project WATERPEAT outputs include:

- Data, conceptual and numerical models and a report on peatland hydrology and runoff water quality variations,
- New methods to delineate peatlands forming the basis for peatland hydrological unit and peatland management, water protection and fire risk control,

[7] press release Norway Government 26.5.2010 No:66/10
[8] press release Finnish Ministry of Agric. and Forestry 7.10.2017

- A critical review and an assessment of experience and expertise on mitigation methods (water treatment, restoration, land management),
- Pilot tests on mitigation methods,
- An on-line (open access) course on "peatland water management",
- Scientific papers in leading journals and presentation in relevant conferences (e.g. EGU sessions on "Peatland Hydrology" or "Peatlands Under Pressure"),
- PhDs from NUIG and UO, in total 2-3 PhDs, and strengthening of post-doctoral careers (all partners),
- Policy briefs and communications to stakeholders at relevant events (e.g. drainage days, water utility days etc.),
- Face-to-face meetings with stakeholders such as ministries, and regional environmental protection.
  Methods to monitor and observe and connect the data to internet with better visibility and use of the data suing ICT and IoT approaches,
- Mobility for senior researchers to visit different peatland sites and enrol an Indonesian PhD at UO.

The output is also listed as deliverables after each work package (WP).

**2.3 Exploitation and communication activities**

The project outcomes will be **clearly** presented to stakeholders and the scientific community. This includes www pages, fact sheets, high quality presentations in conferences and national seminars. Direct contact will be kept with key stakeholders (face-to-face meetings, emails etc.) A **short-course** on peatland water management will be created for **PhD students** to transform the knowledge to the next generation of scientists and authorities. A buzz **video** will be made for citizens **to inform and increase their awareness** (on the main message and results). Communication will also be **by tweets, policy briefs and face-to-face meetings**. Outreach material will be made available on the project website. The results will be communicated to the **scientific community** in conferences (e.g. special session at EGU2021), in PhD theses, and through scientific open access publications and reviews in high impact journals. The data produced will be stored and published as open data, metadata and data publications.

A c**ommunication plan** will be further developed in WP4 (with experts in communication at UO) with several specific actions to **target our audiences** such as the scientific community, policy makers**,** conservation agencies, utilities, industry, NGOs for water and peatland protection agencies (see also letters of commitment). **The key aspects of the communication plan are to:**

- Identify key stakeholders and develop a network of contacts of policy makers, NGOs, industry and SME innovation sector in the peatland water research and management area.
- Set the priorities for reaching our target audiences and decide the best time to reach each audience to support their decision-making,
- Define clear communication objectives adapted to reach the identified target audiences (e.g. utilities, policy makers, researchers),
- Outline the key information and clear story lines to convey the take home message efficiently for each defined audience using appropriate and high-quality communication tools,
- Develop and maintain a list and timing of actions to reach (communication matrix).

The project includes 16 stakeholders with commitment letters (see appended letters). These stakeholders have different backgrounds providing diversity and adding to the holistic approached adopted. These stakeholders are committed to participation. Others will be added during the project (see also the stakeholder mapping task in WP4).

**2.4 Market knowledge and economic advantages/return of investment**

Peatland management affects water quality and quantity negatively in many ways. Peatlands are used intensively, but they are also being restored for biodiversity, carbon sequestration and flood mitigation objectives. The use of these lands provides socio-economic benefits, such as agricultural goods and forestry products. In Finland, peatlands provide 25 % of the annual forestry growth and is of considerable economic importance. **With the projected transformation towards a bioeconomy-driven society (EU and National strategy goals), it is likely that the use of peatlands will continue or increase, but if not properly handled, also large impacts on surface water systems may follow.** Knowledge and methods are urgently needed on how to deal with peatlands to limit environmental impacts. This includes methods that:

- Provide solutions to deal with drainage problems (poor drainage), flooding risks, water quality issues, subsidence (soil loss), biodiversity loss, GHG emissions, and peatland fire
- Allow a transition towards sustainable systems, where valuable water systems are better protected, and some peatlands restored or used less intensively.

Related to peat soils and water management, the "**commercial market"** is involved in land drainage activities (agriculture, forestry, peat extraction), consultancy and advisory services on land and water management, development of water quality improvement and treatment solutions, safe drinking water production, tourism as linked to peatlands, aquaculture, recreation, fisheries and hunting, and the other ecosystem services strongly linked to peatlands. The proposed water management ICT and IoT system development is a new concept, and will provide new market opportunities, typically for the SME industry.

## 3. IMPLEMENTATION

### 3.1 Overall coherence and effectiveness of the work plan

The work starts with **WP1**, which gathers and analyses peatland hydrology and geochemistry to assess reasons and processes that control leaching from peatland drainage. The first task aims to look at peatland at catchment and sub-catchment scale, and to develop methods to conceptualize the overall hydrology and hydrogeology system and delineate peatlands based on remote sensing. We will use data from research sites and national monitoring. In **WP2**, the focus is on methods to reduce negative impacts of drainage. The work starts with a review, where current data, knowledge and past practical experience is gathered. Our approach is holistic as we jointly assess the key environmental targets such as leaching and pollutant control, biodiversity restoration, flood control, fire (drought) control, and GHG emission control considering also socio-economic, climatic and other constrains. **WP3** integrates information from WP1 and WP2 to develop methods for more integrated and catchment-based peatland water management. First, visual conceptual (schematic) models are created to illustrate the peatland system as a unit including key aspects of hydrology, leaching and environmental protection. This is done to integrate partners' knowledge and provide complex site information in a visual form for stakeholder communication. In addition, conceptual models serve as a starting point for the numerical modelling task. Model simulations will be carried out to assess different water level controls and drainage options, impact of measures, and to assess extremes and climate change impacts etc. In WP3, we look into real-life water management and monitoring using some important and complex peatland management cases. **WP4** is dedicated to stakeholder communication, dissemination and integration or results. **WP5** is project management.

The WPs are divided into different tasks and sub-tasks and reported in deliverables (often as one deliverable per task). The WPs are listed below with a more detailed description on pages 10-14.

| WP | WP Title | Duration |
|---|---|---|
| WP1 | Analysis of peatland use impacts on hydrology and water quality | 1-24 |
| WP2 | Solutions for efficient water management and water quality control | 1-28 |
| WP3 | Tools for integrated land and water management on peat soils | 1-36 |
| WP4 | Stakeholder involvement and communication to outline best management options | 1-36 |
| WP5 | Project management and coordination | 1-36 |

| Deliverable | | Due |
|---|---|---|
| D1.1 | Methods to cost-efficiently delineate peatland catchments and observe land use changes | 24 |
| D1.2 | Data and information on key water quantity and quality processes from experimental sites | 24 |
| D2.1 | Literature review on restoration, water treatment methods and land management options | 14 |
| D2.2 | Report on mitigation experiments (leaching control, drainage and runoff water treatments) | 28 |
| D3.1 | Visually appealing (high quality) schematics on peatlands processes and mitigation options | 20 |
| D3.2 | Report on modelling, analysis of extreme events and assessment of future climate impacts, including a set of model parameter ranges for soft calibration of hydrological models | 34 |
| D3.3 | Options for efficient monitoring: a synthesis report on methods with applications to important management cases | 36 |
| D4.1 | Dissemination plan, communication matrix and stakeholder map | 1 |

| | | |
|---|---|---|
| D4.2 | Stakeholder opinion assessment with a simple multicriteria analysis | 18-22 |
| D4.3 | Newsletter, www, twitter (M1-M36, when news appears) | 1-36 |
| D4.4 | Policy briefs (M12-M36) | 12-36 |
| D4.5 | Poster and high advocacy presentation | 6,24,36 |
| D4.6 | On-line training course (M30, with a training event M34) | 30 (36) |
| D4.7 | Final legacy package on peatland water management | 36 |

| **Main milestones** | | |
|---|---|---|
| **Year 1** | **Year 2** | **Year 3** |
| M1: Kick-off: detailed plans on research and first stakeholder involvement, M2: WP1 First analysis of site data, M3: Methods and sites for delineation decided, M4: Hydrology studies reviewed, M5: Stakeholder meetings start, M6: Review of mitigation options outlined. | M7: Mitigation studies and experiments start, M8: Conceptual models drafted for discussion, M9: Numerical models calibrated and validated, M10: Cases for monitoring and mitigation options studies outlined. | M11: Project final products outlined (policy briefs, legacy package, course etc.), M12: Stakeholder workshop and feedback, M13: Final product content decided, and M14: Project outputs ready. |

**Resources to be committed**

The total budget is 1 086 243 €, with REQUESTED FUNDING **896 843 €**. The budget details are as follows:

- **Permanent staff**: 355 k€ for staff at NIBIO research institute.
- **Non-permanent staff**: for researchers, post-docs and PhDs at UO (230 k€) and a PhD at NUIG (70 k€), with overheads following national rules (236 k€ in total).
- **Travel** (total 69 k€) costs estimate 15 000 – 18 000 € per partner for common projects meetings (4 meetings), field work, conferences (2 conferences), and stakeholder workshops (4-6 events per partner).
- **Consumables** (total 54.8€) include mainly cost of water quality analysis and laboratory consumables.
- **Equipment** (total 25.8 k€) equipment used for field measurements (e.g. supplementary or new pressure sensors, pH and EC sensors for research sites).
- **Other costs** (total 35 k€) include grants/stipends to Indonesian researchers (up to 20 k€ from UO), and WP4 dissemination related costs (graphic design, printing etc. 5 k€) and open access publication costs (10 k€).
- **Own contribution** is UO (150 k€, as AoF funds 70 %, 30% is funded by UO of the Finnish budget) and UGM (40 k€ own funding). The permanent staff for UO and NUIG is not included in the cost assessment.

**Distribution of work between partners and WPs (L = WP lead) with total budget and person months (PMs).**

| **Partner short name** | **WP1** | **WP2** | **WP3** | **WP4** | **WP5** | **Total PMs** | *Budget (k€)* | ***Requested funding** (k€)* |
|---|---|---|---|---|---|---|---|---|
| UO | 13 | 16 | **20 (L)** | **10 (L)** | **5 (L)** | 64 | 498 | **348** |
| NUIG | 18 | **20 (L)** | 2 | 4 | 1 | 45 | 148 | **148** |
| NIBIO | **12 (L)** | 2 | 8 | 4 | 1 | 27 | 400 | **400** |
| UGM | 3 | 2 | 4 | 2 | 1 | 12 | 40 | - |
| **Total** | 46 | 40 | 34 | 20 | 8 | **148** | | **896 843 €** |

**Work package description**

| WP number | 1 | Lead partner: NIBIO | Start Date: Month 1 | End Date: Month 24 |
|---|---|---|---|---|
| WP title | Analysis of peatland use impacts on hydrology and water quality | | | |
| Participant | UO (13 PMs) | NUIG (18 PMs) | NIBIO (12 PMs) | UGM (3 PMs) |

**Objective:** The main objective is to improve understanding on how peatland hydrology and water quality change with land use (crops/forests) and management practices (restoration/drainage, fertilization/management intensity).
*Specific objectives are to:*

- compare data on peatland hydrology and water quality, analyse results of on-going experimental sites, and upscale results for different type of peatlands (e.g. riverine peatlands, Atlantic raised bogs, groundwater-dependent systems, tropical).
- test and develop methods to measure peatland catchments properties cost-efficiently using ground observations and remote sensing. Analyse, generalize and publish a database on peat properties (Boreal, Atlantic coastal, Tropical systems).
- analyse and assess how peatland hydrology and water quality change with time due to short-term changes (land use, drainage, fire) and long-term changes (land use, subsidence, fire). Assess how and when restoration changes peatland hydrological functions (storage, flood retention, water quality).
- analyse impacts of drainage on water quality (DOC, P, Fe, and acidity in particular). Investigate processes leading to Fe, suspended solids (SS), pH and DOC leaching and transport in a peat dominated catchment.

**Description of work:** We will connect research sites, infrastructure and national monitoring programmes. Data on land cover, soil properties, land use, climate, hydrology and water chemistry from peat-dominated catchments will be analysed. A joint assessment will strengthen our understanding on peatland hydrology and water quality variations, and the impact of climate and land use. This forms the basis for improved land use planning, cost-efficient water treatment methods and fire risk reduction outlined in WP2 and WP3.

**Task 1.1 Peatland catchment delineation, peat soil subsidence and peat soil and subsoil hydrological properties.** Lead NIBIO, partners involved: UO, UGM. We will use remote sensing, drones, site visits and soil sampling study methods to observe the physical settings and boundary conditions of the peatland catchments. Changes in past land use will be observed using air photos and remote sensing (location of drained areas, ditching history, pristine systems, restoration, subsidence, forest biomass, hydraulic controls). We also look into different boundaries and controls on hydrology at catchment-scale caused by (i) subsidence and fire (Finland, Norway, Indonesia) (ii) river flooding including changes due to increased subsidence (sites in Finland and Norway) (iii) river dredging (Finland), and (iv) coastal tides and influence of subsidence on flooding and salt water intrusion (South-Sumatran lowlands in Indonesia). The contact of the peatlands to the overall hydrogeological setting will be studied (e.g. using maps, piezometers, environmental tracers, numerical models in collaboration with WP3).

**Task 1.2 Analysis of water balance data and water quality.** Lead NUIG. We will analyse data and collect new data on hydrology and water quality processes from field site experiments, mesocosm experiments and column tests.

**Study A) Field sites:** Lead UO, partners involved: NIBIO, UGM. We use detailed data on soil moisture, water table, evapotranspiration, runoff, precipitation from intensively **monitored experimental sites** established in Finland (since 2017), Norway (since 2018) and Indonesia (since 2016). In situ measurement of hydraulic conductivity and peat soil water retention will be done for the Indonesian site (as these are missing). The sites are all intensively monitored, but with a slightly different set-up to study different research questions. The Finnish grassland sites (which lie in a flat landscape) have runoff measurements including water quality and stable isotope data from six small sub-catchments. The Indonesian forest site (six sites) lies on a peat island and has Sap flow and Dendrometer monitoring. The two Norwegian grassland sites have detailed hydrology, water quality and GHG sampling.

**Study B) Rainfall simulation experiment:** Lead NUIG, partners involved: UO, NIBIO. Peat samples will be transferred into 1-m long, 0.0225 m wide and 0.3 m deep flumes, so as they form a continuous surface. The flumes will be instrumented so as the water table may be controlled. The flumes will be set up in triplicate and will be operated in three water table regimes: (1) full saturated (2) fully drained (3) fluctuating water table. All will be subject to maintenance fertiliser applications, applied as superphosphate. Consistent with normal agricultural practices, the fertiliser will be applied two times per year. The flumes will be stored in the open air, so will be subject to normal rainfall conditions. However, at time intervals of 1 month, the flumes will be placed under a rainfall simulator and subject to a controlled rainfall event with an intensity of 10 mm/hr (a common intensity in Ireland). During these

events, surface runoff will be collected and tested for P, N and C species. Understanding the movement of P between the various P-pools in the soil (labile, organic, residual, etc.) will also inform the effective management of the soil.
**Leaching experiment** Lead NUIG, partners involved: NIBIO, UO. Experimental columns, set up in triplicate and each 0.1 m wide and 0.3 m deep, will be amended P fertiliser and subject to controlled rainfall events. Similar to Study B, three hydrological regimes will be examined in the columns: (i) full saturated (ii) fully drained (iii) fluctuating water table. Throughout the study, effluent samples will be collected from the columns. At the end of the study, the columns will be deconstructed and tested for the P species in accordance with the standard methods. "Path analysis" statistics will be conducted to understand the movement of P between the storage pools.

**Deliverables**: **D1.1** Methods to cost-efficiently delineate peatland catchments and observe land use changes (M24). **D1.2** Data and information on key water quantity and quality processes from experimental sites (M24).

| **WP number** | **2** | **Lead partner: NUIG** | **Start Date: Month 1** | **End Date: Month 28** |
|---|---|---|---|---|
| **WP title** | **Solutions for efficient water management and water quality control** | | | |
| **Participant** | (UO 16 PMs) | NUIG (20 PMs) | NIBIO (2 PMs) | UGM (2 PMs) |

**Objectives:** A critical review will be made (Task 2.1) on different options to retain water, reduce leaching and pollution. Novel methods will be further studied in Tasks 2.2-2.4.
*Specific objectives are to:*

- review methods and approaches to limit and reduce nutrient, metal and acidity leaching from drained peatlands.
- identify and assess mitigation options using (i) novel media for soil amendments (ii) controlled drainage (iii) drainage water treatment approaches to reduce nutrient, metal, sediment and C losses.

**Description of work**
**Task 2.1 Review on peatland restoration, buffers and treatment methods.** Lead UO, NIBIO, NUIG. Building on our past expertise and on-going work, existing literature and stakeholder knowledge (consultation, interview of planners, consultants, utilities, land users), a review will be made on potential methods to retain water and reduce the environmental impacts (e.g. leaching, biodiversity, floods, GHG emissions, fire). We will consider cost-efficiency, stakeholder acceptance, maintenance requirement and different regional and local conditions and constrains.
**Task 2.2 Impact of soil amendments to reduce runoff and leaching.** Lead NUIG. We will determine the risks posed by organic soils, unamended and amended by superphosphate, to the environment by the runoff of P, N and C. Using the surface runoff water collected from WP1/Task 1.2, a series of small-scale batch studies will be conducted to determine appropriate amendments to be applied to the lower section of the soil flumes of each replicated slab. The maintenance fertiliser applications and storage/rainfall simulator regime will be repeated as in WP1. During the runoff events, surface runoff samples will be collected and tested for P, N and C species.
**Task 2.3 New methods for water treatment.** Lead UO. We will test and report on new options for water treatment and leaching control that have not been documented before. **Study A** Impact of controlled drainage (UO). **Study B** New options for water treatment in peat extraction areas e.g., through the recovery and recycling of used coagulant chemicals (reduce impacts and improve sustainability), utilization of novel (hybrid and/or biodegradable) coagulants in runoff water treatment (UO). **Study C** Impact of raised water table on peatlands, restoration and improved water retention (UO, NIBIO).
**Task 2.4 Automatic drainage water control and regulation.** Lead UO. We will develop methods to better control water levels using ditch structures, automatic level control and on-line monitoring. In this respect, the idea is to retain water, increase water availability for crops, but reduce the environmental impacts such as leaching and runoff.

**Deliverables: D2.1** Literature review on restoration, water treatment methods and land management options (M14**). D2.2** Report on mitigation experiments (leaching control, drainage and runoff water treatments) (M28).

| **WP number** | **3** | **Lead partner: UO** | **Start Date: Month 1** | **End Date: Month 36** |
|---|---|---|---|---|
| **WP title** | **Tools for integrated land and water management on peat soils** | | | |
| **Participant** | UO (20 PMs) | NUIG (2 PMs) | NIBIO (8 PMs) | UGM (4 PMs) |

**Objective:** The main objective is to test and develop tools that can be used in peatland planning and water management.

*Specific objectives are to:*

- develop a systematic approach to analyse and understand peatland land use issues and to implement cost-efficient water management solutions to key problem cases
- develop monitoring solutions with industry (ICT-sector, remote sensing, consultancy) and recommend reliable methods for objective monitoring and water management. Critically review flaws and uncertainties in the current practices of compliance monitoring (peat industry, forestry, plantations etc.)
- improve the capacity to model and assess land and water management and restoration actions on peatlands using different numerical approaches, and to forecast impacts of land use and climate change on hydrology and water quality (N, P, DOC, acidity, Fe transport). This includes numerical methods, databases, ICT and IoT solutions
- develop improved monitoring and assessment methods for different cases such as land use zoning (more refined planning), peatland protection and restoration, and methods to reliably measure and assess the success of such protection and zoning considering environmental protection and human needs

**Description of work:** Output from WP1 and WP2 will be integrated (summarized) and further developed for important peatland management cases in an interdisciplinary setting.

**Task 3.1 Development of conceptual models for management option visualization.** Lead UO, all partners. We will integrate our knowledge and develop visual schematics that show the key process (soil, hydrology, water quality, climate) and demonstrate how land use and water management affect these processes. These schematics will be used in WP4 and also provide the starting point for numerical modelling (Task 3.2).

**Tasks 3.2 Modelling hydrology and water quality variation.** Lead UO, partners involved: NIBIO. We continue on-going work on peatland modelling using e.g. DRAINMOD[9], INCA, SWAT, COUP, HGS, conceptual and statistical approaches. Novel approaches, including coding in PHYTON, will be used to detect changes based on areal images and satellite data will be used to detect past land use changes that are needed to calibrate the models (the past must first be simulated correctly). Methods to observe model state parameters on-line (remote sensing, sensors) and update the models will be tested (data assimilation). The validated models will be used to study hydrology and water quality variation and simulate impacts of extreme events and climate change (using e.g. RCP 4.5 downscaled climate data). Uncertainty will be carefully addressed.

**Task 3.3 Improved monitoring and water management assessment.** Lead UO, partners involved: NIBIO, UGM. Observing land cover changes (forests growth, subsidence rate, restoration success, fire) and water level changes (e.g. water table, soil moisture, lake and river levels) provide essential information to assess peatland land and water management at various scales. *In-situ* monitoring (e.g. online sensors) and remote sensing (satellites, drones) provide cost-efficient methods to access data from poorly accessible and remote sites, such as many peatlands, where also acidity may limit permanent sensor installation on ground. We outline various options for data sharing on-line and knowledge uptake using novel ICT technologies and IoT (collaboration with UO - WaterEcosystem ICT cluster). **The observation methods will be developed to test cases: Case A** Land use zoning for peatland use and ecosystem protection (connectivity, pristine, close to pristine sites) at catchment-scale in FIN and IND. **Case B** River water quality variations and optimal water intake in FIN (for drinking water, industrial water use). **Case C** Fire risk and compliance monitoring (e.g. 0,4 m required groundwater level, Carbon balance accounting) in IND.

**Deliverables: D3.1** Visually appealing (high quality) schematics on peatlands processes and mitigation options (M20). **D3.2** Report on modelling, analysis of extreme events and assessment of future climate impacts, including a set of model parameter ranges for soft calibration of hydrological models (M34). **D3.3** Options for efficient monitoring: a synthesis report on methods with applications to important management cases (M36).

| **WP number** | **4** | **Lead partner: UO** | **Start Date: Month 1** | **End Date: Month 36** |
|---|---|---|---|---|
| **WP title** | **Stakeholder involvement and communication to outline best management options** | | | |
| **Participant** | UO (10 PMs) | NUIG (4 PM) | NIBIO (4 PMs) | UGM (2 PMs) |

**Objective:** The main objectives are to inform about the project results, engage in a dialogue with stakeholders, and to provide high quality, user-friendly project outputs.

*Specific objectives are to:*

- provide a systematic approach to stakeholder engagement and innovation collaboration

[9] Mohammadighavam&Kløve.2016. Evaluation of DRAINMOD 6.1 for hydrological simulations of peat extraction. *J. Irr. Drainage Eng.*

| |
|---|
| • inform about the project, integrate stakeholder's views, disseminate project results. |
| **Description of work:** Projects results will be integrated (summarized) and further co-developed in an interdisciplinary setting with stakeholders.<br>**Task 4.1 Dissemination plan.** Lead UO. A dissemination plan will be made in the beginning of the project. This includes a communication matrix of events to general public, the scientific community, national and regional policy stakeholders. Publications will be made accessible for all.<br>**Task 4.2 Stakeholder mapping.** Lead UO, all partners. Before the project starts we will map relevant stakeholders. The list will be updated every 6 months. The stakeholders already committed provide the starting point.<br>**Task 4.3 Expert-stakeholder workshops and face-to-face meetings.** Linked to work in WP1-WP3, we will meet different stakeholders. This will be done at project start, mid-term and at the end. We will summarize stakeholder views, needs and bottlenecks in information regarding current practices for organic soil related land and mater management. Peatland use and protection are sensitive topics almost everywhere. The group has long experience with working with various stakeholders. A simple multicriteria methods will be used as a starting point to outline stakeholder preferences, conflict resolution, and to find solutions that are acceptable.<br>**Task 4.4 Newsletter, www, twitter.** Lead UO We will regularly inform different stakeholder groups about the project via a Newsletter, www pages on Research gate, twitter tweets.<br>**Task 4.5 Policy briefs on peatland water management.** Lead UO A series of 4-6 policy briefs will be produced summarizing key policy relevant issues and findings of the project. The work bbuilds on project results, previous scientific knowledge and legislation (e.g on rewetting of peatlands, EU Parliament - Resolution on Wilderness in Europe, WFD).<br>**Task 4.6 Project poster and ppt presentation.** Lead UO A visually appealing poster, project handout and power point presentations will be made and targeted at stakeholders (ministries, NGOs).<br>**Task 4.7 On-line training course.** Lead UO We will develop an on-line and public access training course intended for experts and graduate students. In a series of 8-10 lectures and videos with several examples and illustration, we will summarize the key findings and provide experts with tools to better understand and deal with various issues related to peatland water management.<br>**Task 4.8 Final legacy package on peatland water management.** We will develop a user-friendly final legacy package where our main results, recommendations, deliverables and data can be found and made freely available on-line. |
| **Deliverables: D4.1** Dissemination plan, communication matrix and stakeholder map (M1, updated every 6 months), **D4.2** Stakeholder opinion assessment with a simple multicriteria analysis (M18-M22). **D4.3** Newsletter, www, twitter (M1-M36, when news appears). **D4.4** Policy briefs (M12-M36). **D4.5** Poster and high advocacy presentation (M6, M24, M36). **D4.6** On-line training course (M30, with a training event M34). **D4.7** Final legacy package (draft M30, final revision M36). |

| **WP number** | **5** | **Lead partner: UO** | **Start Date: Month 1 End Date: Month 36** | |
|---|---|---|---|---|
| **WP title** | **Project management and coordination** | | | |
| **Participant** | UO (5 PMs) | NUIG (1 PM) | NIBIO (1 PMs) | UGM (1 PMs) |
| **Objective:** Swift and efficient running of the project. Reporting and communication to WaterJPI and nationally. | | | | |
| **Task 5.1 Project follow up.** Regular meetings will be held (four meetings planned). In between meetings, the project progress is followed by Skype meetings. Minutes and agendas will be prepared by UO.<br>**Task 5.2 Reporting.** Reporting to WaterJPI (UO) and national funders will be made as required by all partners receiving funds.<br>**Task 5.3 Project management group.** Leaders form each unit and the project coordinator. Meetings occur regularly to discuss the work plan and progress according to WP1-WP4. | | | | |
| **Deliverables: D5.1** Project meetings and skype meetings (agenda, minutes). **D5.2 Reporting** (M1, mid-term, end). | | | | |

### 3.1 Appropriateness of the management structure and procedures, including quality management

The main objective of the Consortium-level management in WATERPEAT is to keep the project on track to ensure good scientific outcomes, project visibility and good impact. Task leads are defined where each task leading to a deliverable of milestone (for clear outline or responsibilities, project management and easy follow-up of the project). The project partner roles, leaderships and responsibilities are organized as:

- **WATERPEAT coordinator is** responsible for organization of the project. The co-ordination activities are organized in WP5. This includes to organize regular project follow up with skype and to plan four project partner meetings. UO will assign a financial controller and a project assistant (e.g. to set up the project homepage and update it regularly)**.** The coordinator Prof. Bjørn Kløve is experienced (e.g. he has lead three large EU projects).
- **WATERPEAT coordinator and WP leaders** are responsible for the **overall scientific leadership.** WP leaders are responsible for WP project plans and their follow-up. They also update the WPs and lead the meeting on WPs specific issues on Skype and during partner meetings. WATERPEAT uses a structure with a leader and co-leaders as follows:
    - **WP1:** H. Silvennoinen (NIBIO)/ J. Kværner (NIBIO)
    - **WP2:** M. Healy (NUIG)/ E. Heiderscheidt (UO)
    - **WP3:** B.Kløve (UO)/ H. Marttila(UO)
    - **WP4:** B.Kløve (UO)/P.Taskinen (UO-WaterEcosystem)
    - **WP5:** B.Kløve (UO)/E. Heiderscheidt (UO)
- **WATERPEAT** Principle Investigators (PIs) are responsible to actively be involved in the project research and to carry out the research and lead the partner activities according to the work plan. The PIs will plan local stakeholder meetings and also the local work follow-up. The PIs are experienced, as illustrated by their CVs.

**Gender issues:** WATERPEAT is strongly committed to the principle of equal opportunities. The WPs leaderships' tasks above are carried out by four males and three females.

**All consortium partners form the WATERPEAT decision making body "General Assembly"** (*all four partners*) that meet during project meetings, skype or if needed by email. The tasks are mainly related to overall project issues listed in the project consortium agreement (e.g. solutions in case of conflicts etc.) which follow the DESCA2020 simplified consortium agreement model. Special sections will include IPR issues, rules of authorships and the overall management as explained above.

**Stakeholder advisory process** - Meetings will be organized locally by the PI and the stakeholder and by teleconferences (e.g. skype) and emails. The stakeholders will provide feedback on project content and results, and advise on e.g. on stakeholder related dissemination activities (see WP4, commitment letters).

### 3.2 Risk management

The project tasks are realistic and carefully planned building on partners' past research expertise. The group include experienced researchers that have to some extent overlapping experience on critical topics of the proposal (peatlands, hydrology, water treatment, land use planning, remote sensing, modelling, stakeholder involvement etc.), making the project less risky. Also the stakeholders have different expertise and the partners know the stakeholders, which is a strength. This approach is designed considering maximum impact, but minimum risk of failure.

To limit project execution risks, regular follow-up meetings will be held via Skype in addition to the regular project meetings. This strengthens the project internal communication and the commitment to the common project goals. In addition, a consortium agreement will be made with practices to deal with the identified risks. Several partners have worked closely together earlier, which also reduces the risk and allows for a smooth project start. UO will employed a PhD from UGM Indonesian research group to work on the Indonesian peatlands as part of the project to strengthen the consortium collaboration. Research exchange between groups is also planned.

### 3.3 Potential and commitment of the consortium to realise the project

The partners are committed to their tasks according to their research interest and focus. Several partners have worked together before, which reduces the risks related to project implementation. UO (the lead partner) has worked with the NIBIO staff for more than 15 years, with UGM more than 3 years, and with NUIG about 2 years. The partners are all experienced in running project and delivering results on time. All share the interest related to environmental challenges related to peatland water management.

**WATERPEAT** GANTT CHART

| Month/ Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Work Package 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Work Package 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Work Package 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Work Package 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Work Package 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Deliverable | D4.1 D4.3 | | | | | D4.2 D4.5 | | | | | | D4.4 | | D2.1 D4.3 | | | | D4.2 | | D3.1 | | | D1.1 D1.2 D4.3 D4.4 D4.5 | | | | | D2.2 | | D4.6 D4.7 | | | | D3.2 D4.3 D4.5 D4.7 | D3.3 D4.4 D4.6 | |
| Milestone | M1 | | | | M2 M4 | M3 M4 | | | M5 M6 | | | | M7 M8 | | | | M9 M10 | | M11 | | | | | M12 | | | | | | M13 | | | | | M14 | |
| Progress Monitoring | X | s | s | s | s | s | | | s | X | | s | | | s | | | s | | | s | | | X | | | | s | | | s | | | X | | s |
| Mobility Schemes | Mobility from Indonesia to Finland and Norway | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Risk Management | R1 | | R2----------R2 | | | | | | | R3 | | R4----------R4 | | | | | | | | | | | | R5 | | R6----------R6 | | | | | | | | R7 | | |
| Others | | | | EGU conference | | | | | | | | | | | | | | | | | | | EGU conference and special session participation with project results | | | | | | | | | | | | | |

M1: Kick-off and detailed plans on research and first stakeholder involvement, M2: WP1 First analysis of site data, M3: Methods and sites for delineation decided, M4: Hydrology studies reviewed, M5: Stakeholder meeting and feedback, M6: Review of mitigation options outlined, M7: Mitigation studies and experiments start, M8: Conceptual models drafted for discussion, M9: Numerical models calibrated/validated, M10: Cases for monitoring and mitigation options studies outlined, M11: Project final products outlined (policy briefs, legacy package, course etc.), M12: Stakeholder workshop and feedback, M13: Final product content decided, and M14: Project outputs ready.

X = project meeting (face-to-face), s = project meeting (skype)

R1 = partners' tasks reviewed in a common meeting in Finland and revision made if needed. R2 = The project followed up by regular skype meetings, R3 = progress assessed at a common meeting in Indonesia, R4 = regular skype meetings, R5 = progress assessed in a meeting in Ireland, R6= progress followed by skype meetings, R7: final meeting in Norway.

## 4. DESCRIPTION OF THE PARTICIPATING RESEARCHERS

| Partner Number, according to Part A | Research Team Members (for personnel include name, position and affiliation) | General Description |
|---|---|---|
| Partner 1 (Bjørn Kløve) | Professor Bjørn Kløve, Head of unit, Water resources and environmental engineering | B. Kløve has 25 years of experience with peatland related land and water management. Key expertise includes hydrology, drainage, water quality, water treatment and modelling. He has led several national and international projects. Published 150 peer-reviewed papers (h-index 29). PI of over 50 research projects to date. |
| | Dr. Hannu Marttila, Associate Professor, Water resources and environmental engineering | H. Marttila has 14 years of experience with peatland land and water management. Key expertise includes hydrology, water quality, ecology, land use change assessment. He has led several national projects. Published 60 peer-reviewed papers (h-index 12). |
| | Dr. Elisangela Heiderscheidt, Senior researcher, Water resources and environmental engineering | E. Heiderscheidt has over 10 years' experience in water and wastewater treatment processes such as chemical purification, constructed wetlands and filter systems. Expertise in water engineering, water treatment, recycling technologies. PhD in the development of chemical treatment methods for peat extraction runoff water. |
| Partner 2 (Mark Healy) | Dr. Mark Healy | M. Healy has expertise in nutrient management, treatment and mitigation. Author of 104 journal papers, of which at least 60 are relevant to the call (h-index 26). PI of over 30 research projects to date. |
| | Dr Oisín Callery, Postdoctoral Researcher, NUI Galway | O. Callery has expertise in environmental impact assessment, modelling of wastewater treatment processes, and the nutrient dynamics of peatland forests. |
| Partner 3 (Hanna Silvennoinen) | Dr. Hanna Silvennoinen, Research Scientist, Soil quality and climate change | H. Silvennoinen is a geochemist, specialised on GHG emissions and their mitigation. Currently participating in multiple projects and networks related to peatland use and protection. |
| | Dr. Jens Kværner, Senior Research Scientist, Water Resources | J. Kværner has expertise in hydrogeology and hydrology. More than 15 years' experience with peatlands including impacts of groundwater lowering and hydrological studies. |
| | Dr. Lise Dalsgaard, Research Scientist, Forest and Climate | L. Dalsgaard is experienced in forestry and in estimating soil C accumulation and losses for use in the national GHG inventory and participating in and coordinating projects directed at improving GHG inventory methodology in mineral and organic forest soils. |
| | Dr. Svein Solberg, Research Professor, National Forest Inventory | S. Solberg has +25 expertise in forestry and remote sensing, with focus on disturbance monitoring. Svein has 60 articles in international, peer-reviewed papers. |
| Partner 4 (Oka Karyanto) | MSc. Oka Karyanto | O. Karyanto has 20 years experience from ecosystem research, forestry and agriculture. He has lead many national projects and collaborated with researcher in Europe (e.g UO and NIBIO) and Japan. He has 16 published journal papers (h-index 8). |
| | Dr Satyawan Pudyatmoko | Head of Peatland Working Group. Expert on ecology. 7 journal publications (h-index 5). |
| | Dr Istiarto | Head of Hydraulics Lab, Engineering Faculty. Experienced in hydrology and hydraulics. |

## 5. CAPACITY OF THE CONSORTIUM ORGANISATIONS

| Partner Number (Organisation Name) | | General Description |
|---|---|---|
| Partner 1 (UO) | Role and main responsibilities in the project | Project leadership. WP3-WP5 leader. Expert on peatlands, hydrology, modelling, water quality, water and environmental engineering. |
| | Key research facilities, infrastructure, equipment | Monitoring equipment for peatland hydrology. Modelling environment and software. Water quality monitoring and analysis equipment. Facilities for pilot testing and development. |
| | Relevant publications and/or research/innovation products | Developer of peak runoff control structures required on Finnish peat extraction sites as part of the environmental permit. Developer of constructed wetlands for water treatment. More than 50 publications on peatland water management in leading water journals (e.g WRR, Water Research, Journal of Hydrology) |
| Partner 2 (NUIG) | Role and main responsibilities in the project | WP 2 leader. Expert on water quality, water treatment and environmental engineering. |
| | Key research facilities, infrastructure, equipment | Newly built state-of-the-art engineering building. Soil mechanics laboratories x 2, Environmental laboratories x 2. Konelab nutrient analyser; TP-TP-TC analyser; gas chromatograph; temperature and humidity controlled rooms x 3; rainfall simulators. Access to peatland sites for experimental work. |
| | Relevant publications and/or research/innovation products | Invention disclosure forms submitted on nutrient mitigation technology. More than 20 journal papers on water management in peatlands. >60 papers on mitigation measures, which will inform this proposal. |
| Partner 3 (NIBIO) | Role and main responsibilities in the project | WP1 leader. Expert on land use change, soil science, hydrology, geochemistry, peatlands, remote sensing, environmental research and bioeconomy. |
| | Key research facilities, infrastructure, equipment | We have experience and software for processing remote sensing data, both airborne and satellite data, and both active (LiDAR and SAR) and passive, optical sensors. |
| | Relevant publications and/or research/innovation products | National research institute for bioeconomy with main focus on agriculture and forestry. Expertise on peatland hydrology, remote sensing and biogeochemistry. |
| Partner 4 (UGM) | Role and main responsibilities in the project | Expert on forestry and agriculture on tropical peatlands. Expert on stakeholder interaction. |
| | Key research facilities, infrastructure, equipment | Monitoring and research programme on peatlands in Pedang Island, Borneo and Papua. |
| | Relevant publications and/or research/innovation products | Publications on tropical forestry and agronomy (ranked 1st of Indonesian universities). |